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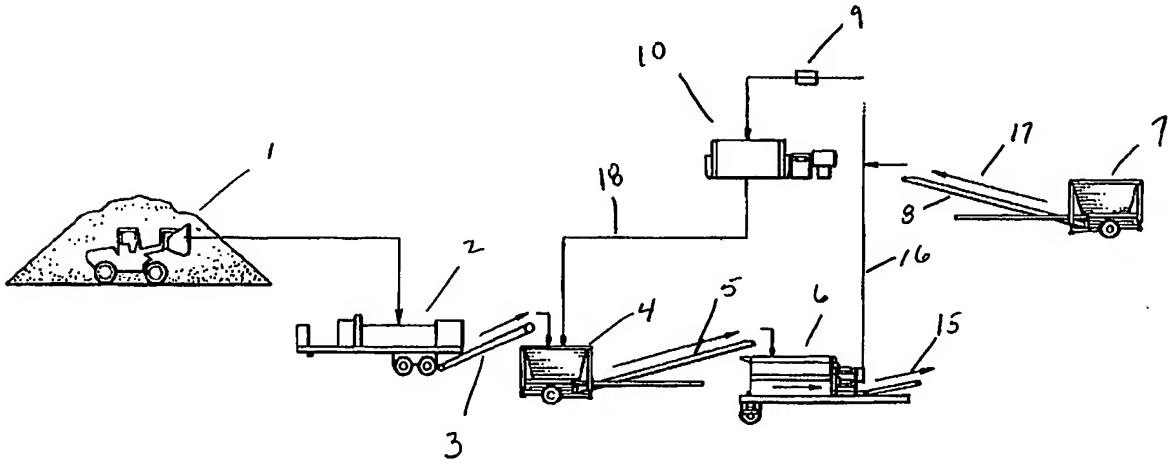
(54) **PROCEDE DE TRAITEMENT, STOCKAGE, MIXAGE POUR L'UTILISATION DES DECHETS DE BARDEAUX RECYCLABLES DANS LA FABRICATION D'ENROBES A CHAUD**

(54) **PROCESS FOR PROCESSING, STORING, BLENDING, AND UTILISING RECYCLABLE MODIFIED SHINGLE WASTE ASPHALT IN THE MANUFACTURING OF HOT MIX**



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PROCESS FOR PROCESSING, STORING, BLENDING AND UTILIZATION OF RECYCLABLE MODIFIED SHINGLE WASTE ASPHALT IN THE MANUFACTURING OF HOT MIX

Background

Field of Invention

This invention relates generally to the recycling of plant waste originating in the manufacture of asphaltic roofing shingles. More precisely, the invention relates to processes and apparatus for preparing this waste to form novel recyclable asphalt materials and for using them as ingredients in asphalt paving compositions.

Prior Art

It is known in the art to use various recyclable materials (recycled asphalt, rubber, glass, fibrous material etc.) in the manufacture of asphaltic paving compositions. It is known that roofing shingle waste products comprise materials that would be useful in making asphalt paving mixtures. It is also known that adding dust to the surface of sticky materials may reduce the likelihood that such materials will agglomerate when placed together. It is known to use shredders and hammer mills to reduce materials to smaller chunks or particles. All of the elements of the apparatus combinations disclosed herein are known with the exception of the modified hammer mill.

It is known that the waste from the manufacture of asphaltic roofing shingles has both advantages and disadvantages as a recycled material. Shingle waste is advantageous in that it includes resinous, particulate and fibrous material (approximately 40% asphalt, 20% cellulose fiber and 40% trap rock granules) all of which is, in certain proportions, compatible with asphalt paving compositions. It is also advantageous that such waste material is available in large quantities. Shingle waste is disadvantageous in that the particulate material, i.e. trap rock, is very abrasive and destructive to rendering tools and the resinous material tends to "gum up" rendering machinery and to agglomerate previously reduced material (thereby reversing the rendering process). The gumming problem results when the asphalt resin flows when it is heated, for example, by the frictional energy generated in the rendering machines and coats the surfaces of the machinery. In summary, it is known that the waste shingle material is useful in paving compositions, but the handling and reducing problems presented by such material have impeded its large scale, commercial adoption.

It is an object of the present invention to provide novel processes and apparatus for producing novel recycled shingle waste products which are capable of being stored and transported and which are useful in the manufacture of hot mix paving compositions. Other objects, features, and advantages of the present invention will become apparent upon reading the following description in conjunction with the drawings and claims.

SUMMARY OF THE INVENTION

In this description the following words have these meanings:

- shingle waste - waste from roofing shingle manufacturing plants and the like including shingles, parts thereof, materials used in the manufacture of shingles and foreign materials;
- modified shingle waste - the product resulting from the first stage of processing in accordance with this invention wherein the shingle waste is reduced to approximately minus ¼ inches in particle size;
- recycled asphalt - asphalt paving material that has been removed from a road or the like for recycling and pulverized or otherwise reduced in size for use in an asphalt plant;
- shingle/asphalt/sand mix - a mixture of predetermined quantities of modified shingle waste, recycled asphalt products and sand.

The present invention includes:

- a process and novel apparatus for processing shingle waste to make a modified shingle waste product that is useful as an ingredient in the manufacture of hot mix paving compositions;
- a continuation of the process in which the modified shingle waste product is mixed with recycled asphalt and/or sand to make a shingle/asphalt/sand mix also useful as an ingredient in the manufacture of hot mix paving compositions;

- further novel apparatus and continuations of the process in which predetermined quantities of modified shingle waste, recycled asphalt, sand, aggregate and liquid asphalt are mixed to form an asphalt paving composition; and

- a novel product, namely a shingle/asphalt/sand mix.

Stated generally, the process for reducing shingle waste to modified shingle waste comprises:

1. shredding masses of shingle waste into large chunks of approximately minus 4 inches;

2. mixing the large chunks with small chunks of approximately minus 1 inch and with dust aggregate of approximately minus ¼ inches;

3. screening the large chunks, small chunks and dust aggregate on one or more screens to separate particles of approximately minus ¼ inch in dimension from over-screen material of larger dimension;

4. mixing the over-screen material with a sufficient quantity of dust aggregate of minus ¼ inches to impede agglomeration;

5. passing the mixture of over-screen material and dust aggregate past a magnet to remove metal;

6. adding water to the mixture of over-screen material and dust aggregate to control dust and to assist in shredding;

7. shredding the mixture of over-screen material and the dust aggregate to reduce the large chunks to small chunks of minus 1 inch;

8. returning the small chunks and dust aggregate to step 2 to be mixed with the large chunks; and

9. continuing the above process steps to produce, in step 3, a desired quantity of screened minus ¼ inch particles, hereafter referred to as "modified shingle waste".

The combination of apparatus for practicing this part of the process of this invention includes a shredder to reduce the shingle waste to large chunks having a largest dimension of approximately 4 inches, a first surge bin to mix the large chunks with small chunks and dust aggregate, a screening plant having one or more screens to separate particles of a modified shingle waste that pass through the screen(s) with a largest dimension of approximately ¼ inches from over-screen material that passes over the screen(s), a second surge bin to supply dust aggregate, an electromagnet and a modified hammer mill in which hammers, pivotally mounted on a rotating flywheel within a drum, are fitted with a pivotally mounted tool. Standard conveyor means may be used to transfer materials from station to station for processing.

It is generally desirable to process the shingle waste at a location remote from an asphalt paving production plant. In most cases shredding will occur at or near shingle waste storage sites near a shingle manufacturing plant. These sites will generally have large quantities of shingle waste piled in storage, randomly mixed and largely agglomerated in masses. Following the first stage of the rendering process described above, the shredded shingles may be stored in piles and shipped in mass quantities with reduced agglomeration. While the dusting during the rendering process reduces the tendency to agglomerate and the modified shingle waste produced by this process is a useful product, agglomeration may increase over time. Unless it is used soon after shredding, the modified shingle waste may clump or stick together making stockpiling, transportation and use difficult. Thus, the distance between the processing site and the asphalt plant that will use the material can be a limiting factor for the use of the modified shingle waste. In the next stage of the process a novel product of shingle/asphalt/sand mix is manufactured to address this problem.

This further stage of processing in the present invention comprises:

10. mixing a predetermined quantity of modified shingle waste with a predetermined amount of pulverized recycled asphalt and sand to make a shingle/asphalt/sand mix.

The predetermined quantities of modified shingle waste, recycled asphalt and sand are set by reference to quantities of each material on hand and ready for recycling, the make-up suitable for easy introduction into an asphalt plant and the mixture characteristics that will result in reduced

agglomeration and good flowability. Generally, the majority of this mixture by weight will be the modified shingle waste.

The quantities of materials on hand for recycling may affect the composition of the mixture. For example, if there was no recycled asphalt available, the mixture may be made with only modified shingle waste and sand. In this case the predetermined quantity of recycled asphalt in the mix would be 0%. Good results can be obtained with sand without recycled asphalt, and this mixture is a preferred embodiment. Recycled asphalt is added to the mixture to dispose of it, but flowability is believed to be obtained primarily from sand in the mix. The mixture can be useful without sand, however, and with recycled asphalt. In that case the predetermined quantity of sand would be 0%.

The factor of easy introduction into an asphalt plant may be explained as follows. An asphalt plant may wish to introduce a certain percentage of recycled fiber in the resulting hot mix. Assuming that the modified shingle waste contains about 20% fiber, the mixture of modified shingle waste and recycled asphalt and sand may be balanced so that the quantities of this mixture introduced in the asphalt plant will introduce the correct amount of fiber into the hot mix.

In preferred embodiments the shingle/asphalt/sand mixture is in the range of about 50% - 80% modified shingles and 50% - 20% recycled asphalt and sand. It is preferred to have a sufficient quantity of sand to obtain good flowability of the mixture which may be determined empirically. It is preferred that the sand be minus ¼" and be a washed classified sand.

The resulting shingle/asphalt/sand mix can be stored and transported without the risk of significant agglomeration. The addition of this process step of blending the modified shingle waste with predetermined quantities of sand and recycled asphalt obtains a significant advantage. Now, different blends of modified shingle waste, recycled asphalt and sand can be made to produce various shingle/asphalt/sand mixes at a location where the necessary reduction and mixing equipment can be established, near an appropriate source of supply of raw materials. These various shingle/asphalt/sand mixes can be stored until required and then shipped to plants for the production of different paving compositions. These plants may be at remote locations where it would be impracticable or uneconomical to establish the reduction and mixing equipment.

The apparatus for combining the modified shingle waste with recycled asphalt includes a first hopper to contain a batch quantity of modified shingle waste and having a controllable discharge means to regulate the discharge of modified shingle waste to a predetermined amount; a second hopper to contain a batch quantity of recycled asphalt and having controllable discharge means to regulate the discharge of recycled asphalt to a predetermined amount, a third hopper to contain a batch quantity of sand and having controllable discharge means to regulate the discharge of sand to a predetermined amount and a conveyor belt including a belt weigh scale to receive and convey the discharged modified shingle waste, recycled asphalt and sand, i.e., the shingle/asphalt/sand mix, to storage or transportation means. These hoppers and discharge control mechanisms, including computer controls, conveyors and belt scales, are within the state of the art and will not be described in further detail.

Both the modified shingle waste and the shingle/asphalt/sand mix may be introduced alone, or together, into a hot mix manufacturing process to make paving compositions. Three distinct production apparatus are involved, namely a conventional batch plant operation, a conventional drum mixer operation and a novel batch plant custom blend operation.

In a conventional batch plant operation, the process of this invention continues with a process for manufacturing asphalt paving composition comprising the steps of:

11. introducing at least one of a predetermined amount of modified shingle waste and a predetermined amount of shingle/asphalt/sand mix to form a recycle mixture;

12. shredding the recycle mixture to minus 1 inch;

13. combining the recycle mixture with predetermined quantities of heated virgin aggregate to form a feed mixture;

14. introducing a controlled amount of liquid asphalt into the feed mixture to complement the asphalt in the recycle mixture such that the total asphalt in the feed mixture reaches a predetermined portion of the feed mixture; and

15. mixing the heated virgin aggregate, the recycle mix, and the liquid asphalt to form an asphaltic hot mix paving composition.

It will be appreciated by those skilled in the art that an operator may choose to add other recycle materials in addition to those specified in step 11. For example, the operator may also add recycled asphalt pavement at this stage to the recycle mixture. Steps 11 and 12 may be practiced at ambient temperature thereby permitting the use of many materials that would not be useful if introduced through the dryer.

A conventional drum mixer operation comprises a drum mixer into which liquid asphalt cement and virgin aggregate supply are mixed and heated to form a paving composition. In the process of this invention, modified shingle waste and/or a shingle/asphalt/sand mix is added to the drum mixer in predetermined quantities to produce a desired paving composition. The paving composition thus manufactured can be stored in asphalt storage silos or asphalt surge bins. Each silo or bin may store a different type of paving composition which has been custom blended with particular quantities of virgin aggregate, modified shingle waste, shingle/asphalt/sand mix and asphalt in the drum mixer.

The batch plant custom blend operation is a novel combination of apparatus similar to the conventional batch-plant described above, but with the addition of hoppers containing modified shingle waste and shingle/asphalt/sand mix and/or other recyclable materials for introduction at ambient temperature. Each hopper has a controlled discharge means for dispensing a predetermined quantity onto a conveyor belt, which is then transported by the conveyor to a shredder where it is reduced and mixed, and discharged onto a conveyor for introduction into an aggregate hopper of the batch-plant operation. The control of the mixture introduced into the plant is determined at the hoppers and These modifications to the conventional batch plant permit it to manufacture, in sequence without shutdown, different types of paving compositions by altering the amount of modified shingle waste and shingle/asphalt/sand mix in the composition of ingredients making up the paving composition.

The custom blend batch plant operation has been designed to allow for the addition of any material, at ambient temperature, to the mix. This plant design is used for materials which cannot be heated by means of a rotary dryer. Instead, these materials are heated by mixing them with heated aggregate which has passed through a dryer. The elevated temperature of the aggregate raises the temperature of such materials so that the final mix temperature meets the required specifications for a hot mix operation. The process permits an operator to vary proportions on a batch by batch basis in

sequential hot mixes to meet all specifications for normal paving compositions in regular operations or for testing mix designs and materials.

The process may include, in addition to the materials described above, any flowable material which is compatible with hot mix paving compositions. Existing asphalt batch plants are designed to allow only one specific recycled material or blend of recycled materials to be introduced by means of a recycled material conveyor. The custom plant allows for more than one type of material, in any proportion, or custom blend to be added on a batch to batch basis. The process is also easily adapted to fully automatic computer control.

Brief Description of the Drawings

In the figures illustrating a preferred embodiment of this invention:

Figure 1 is a schematic diagram of the process and apparatus for reduction of the shingle waste to modified shingle waste;

Figure 2a is a schematic view of a conventional hammer mill;

Figure 2b is a schematic view of an improved hammer mill of this invention;

Figure 2c is a schematic perspective of a modified hammer mill of this invention;

Figure 3 is a schematic diagram of a process and apparatus for blending modified shingle waste with pulverized recycled asphalt and sand;

Figure 4 is a schematic diagram of an asphalt plant using the modified shingle waste of this invention;

Figure 5 is a schematic diagram of a drum mixer asphalt plant using the modified shingle waste of this invention and

Figure 6 is a schematic diagram of an asphalt plant adapted with dispensing apparatus to use modified shingle waste and recycled asphalt in various mixes.

Description of the Preferred Embodiments

Figure 1 shows a preferred embodiment of a process and apparatus to reduce shingle waste into a modified shingle waste of this invention. Shingle waste 1 is fed into a Norkot Maxigrind™ shredder 2 that is sized to reduce the shingle waste to minus four inch chunks, i.e. "large chunks". The large chunks discharge onto a conveyor 3 and are transported to a surge bin 4. Within the surge bin 4, the large chunks are mixed with returning small chunks (sized at minus one inch) and dust aggregate (minus ¼ inch) from a hammer mill 10. The mixture of material comprising large chunks, small chunks and dust aggregate is discharged onto and transported by a conveyor 5 to a screening plant 6 for separation. In the screening plant 6, the material is first screened by a large mesh screen (not shown separately) and the material passing through the large screen is then screened by a smaller mesh screen (not shown separately) to allow minus one quarter inch particles to pass through the lower screen. These minus one quarter inch particles are the modified shingle waste 15, which is a novel product of this invention. It is advantageous to screen the minus one quarter inch material before the hammer mill 10 because much of the highly abrasive trap rock in shingle waste is of this size. Its early removal substantially reduces the wear on the hammer mill 10.

The material passing over the screens (hereafter the "over-screen material 16") is transferred, preferably by a conveyor belt (not shown), to a hammer mill 10. During this transfer to the hammer mill 10, the over-screen material 16 receives a predetermined quantity of minus one quarter inch dust aggregate 17. Water is added before and in the hammer mill 10 to control air borne dust and to facilitate the shredding process in the hammer mill 10. This dust aggregate 17 is stored in a surge bin 7 and discharged onto, and transported by, a conveyor 8 at a predetermined rate. It is then discharged from conveyor 8 onto the over-screen material 16. The rate of passage of the over-screen material 16 and the rate of the discharge of the dust aggregate 17 determine the proportions of the mixture. The over-screen material 16 and dust aggregate 17 are then transferred past a magnet 9 to remove metal and then discharged into a hammer mill 10 to reduce it to small chunks (minus one inch) and to mix the small chunks with the dust aggregate 17. This hammer mill product 18 of small chunks and dust aggregate is then discharged onto a conveyor (not shown) and transported to the surge bin 4 to be mixed with the large chunks as described above. The process continues to produce a desired quantity of screened modified shingle waste 15.

A modified hammer mill 10 with improved hammers is disclosed for reducing the shingle waste. The modifications may be explained in the context of a conventional hammer mill 10a which is illustrated in Figure 2a. A conventional hammer mill 10a has an inlet chute 19, a plurality of hammers 20 pivotally mounted on pins 21 about the face of a rotor 22 mounted on a rotor shaft 23 within an upper concave 24a and a lower concave 24b, the latter having a sizing screen 25 and a plurality of cutting bars 26. Rotor shaft 23 is driven by a motor (not shown) to turn the rotor 22 causing the hammers 20 to swing around to smash and shred materials against the cutting bars 26. The sizing screen 25 permits materials that have been reduced to a predetermined size to pass through and exit the hammer mill to a conveyor 27. The lower concave 24b is hinged to allow oversized materials to pass to exit through the upper concave 24a onto the conveyor 27 without damaging the mill 10a.

Conventional hammer mills may be used to process shingle waste, but the extremely abrasive trap rock in the shingles quickly erodes the hammers 20 and it is difficult, if not impossible, to maintain a desired tolerance between the cutting bars 26 and the hammers 20 to control the size of the reduced materials.

A modified hammer mill of this invention is illustrated in Figures 2b and 2c. It too has an inlet chute 119, a plurality of hammers 120 pivotally mounted on pins 121 about the face of a rotor 122 mounted on a rotor shaft 123 within an upper concave 124a and hinged lower concave 124b. The hammers 120 may be mounted alternately on either side of the plurality of rotors 122 to fully sweep the interior of the mill. In the modified hammer mill, the hammers 120 are reshaped to attenuate (rather than flaring out) from the mounting pin 121 to a cutting tool mount 128 having a cutting tool 129. In preferred embodiments of this invention, tungsten carbide cutting teeth are used for the tools 129. The hardened tools 129 wear slower and maintain tolerances longer than the original hammers 20. Water jets (not shown) may be positioned to spray the tools 129 during processing to cool the tools 129, to reduce erosion of the tool surfaces and to reduce air borne dust in the mill. The hammer mill 10 has a screen plate 125 elevated over the lower concave 124a to replace the cutting bars 26 of the original hammer mill. The shredding of materials happens between the tools 129 and the screen plate 125. The screen plate 125 is aligned to and spaced from the turning circle of the tools 129 by a predetermined distance which is set by means of screen bolts 131 and lower concave adjustment

screw 133 to produce a desired size of shredded materials. Screen plate 125 is perforated with a plurality of holes, preferably round and diamond shaped.

Figure 3 illustrates the process and apparatus for combining the modified shingle waste 15 with recycled asphalt 30 and/or sand 31. In this process step the modified shingle waste 15 resulting from the above process is blended with recycled asphalt 30 and/or sand to make a shingle/asphalt/sand mix 32. The apparatus includes a means for transporting the modified shingle waste, for example a loader 15a, to a first hopper 33 having a controllable discharge means 33a (computer controls permit programmable and remote control) to regulate the discharge of modified shingle waste to a predetermined flowrate; a means for transporting the pulverized asphalt, for example a loader 30a, to a second hopper 34 to contain the recycled asphalt 30 and having similarly controllable discharge means 34a to regulate the discharge of recycled asphalt 30 to a predetermined flowrate; a means for transporting the sand 31, for example a loader 31a, to a third hopper 35 to contain the sand 31 and having similarly controllable discharge means 35a to regulate the discharge of the sand 31 to a predetermined flowrate and a conveyor belt 37 to receive and transport the discharged modified shingle waste 15 and recycled asphalt 30 and sand 31, having a belt scale 38 to weigh the resulting mixture which, as noted above, will be referred to as the shingle/asphalt/sand mix 32.

The modified shingle waste 15 and the shingle/asphalt/sand mix 32 may be introduced into hot mix manufacturing processes to make paving compositions in three distinct ways, in a conventional batch plant operation illustrated in Figure 4, in a drum mixer operation illustrated in Figure 5 or in a batch plant custom blend operation illustrated in Figure 6.

A conventional batch-plant operation 40 for manufacturing asphalt paving compositions is shown in Figure 4. Ordinarily the manufacture comprises the steps of:

1. supplying to a dryer 41 predetermined quantities of virgin aggregate 42 from hoppers 43 discharged onto a conveyor 44 fitted with a belt scale 45;

2. heating the virgin aggregate 42 in the dryer 41 and discharging it onto a conveyor, such as a bucket elevator 46;

3. discharging the heated virgin aggregate 42 onto screens 47 for separation by particle size into a plurality of plant temporary storage bins 49;

4. controlled discharge in predetermined quantities from the plant temporary storage bins 49 into an aggregate hopper 50 and then into a pugmill 51; and

5. adding liquid asphalt cement 52 to such pugmill 51 in predetermined amounts regulated by an asphalt weigh bucket 53.

In this invention, the conventional batch plant 40 is adapted by the following process steps and associated apparatus to use modified shingle waste 15 and/or shingle/asphalt/sand mix 32:

1. mixing predetermined quantities of modified shingle waste 15 and predetermined quantities shingle/asphalt/sand mix 32 in a plant surge bin 54;

2. discharging the mixture 55 of modified shingle waste 15 and shingle/asphalt/sand mix 32 onto a conveyor 56 and transporting same to a shredder 57;

3. shredding the modified shingle waste 15 and shingle/asphalt/sand mix 32 to a size of minus 1 inch;

4. transporting the shredded material 58 into the aggregate hopper 50 to be mixed with the virgin aggregate supply 42 and discharging the resultant mixture into the pugmill 51;

5. adding liquid asphalt 52 to the pugmill 51; and

6. mixing the liquid asphalt 52, shredded material 58 and virgin aggregate supply 42 for a predetermined time in the pugmill 51 to form an asphalt paving composition.

Alternatively, the shredded material 58 may be fed from the shredder 57 and discharged onto the bucket elevator 46 onto virgin aggregate 42 being discharged from the dryer 41. This alternative process, however, has the disadvantage that the asphalt resin in the shredded material 58 may tend to clog the bucket elevator 46, and the plant elements above the pugmill 51. It becomes a problem when the shredded material 58 is stored in an asphalt tower for a long period of time.

The conventional drum mixer operation 60 illustrated in Figure 5 includes a drum mixer 61 which is fed with virgin aggregate 62 from feed hoppers 63 by means of a conveyor belt 64 equipped with a belt scale 65 and with liquid asphalt 66. In this invention, the drum mixer 61 may also receive predetermined quantities of shingle/asphalt/sand mix 32 supplied from a hopper 66 which discharges the shingle/asphalt/sand mix 32 onto a conveyor 67 equipped with a belt scale 68. It is then discharged into a shredder 69 to be shredded to minus 1 inch particles which are discharged onto a conveyor 70 to feed them into the mixer 61. The product of the mixer 61 is discharged onto a drag slat conveyor 71, fed into a shuttle conveyor 72 which discharges the product into one or more of the storage silos 73 for loading onto trucks (not shown).

In the custom plant 80 shown in Figure 6, modified shingle waste 15 and shingle/asphalt/sand mix 32 and other unspecified materials 100 are stored in and discharged from respective feeder hoppers 81, 82 and 83. The discharge is controlled by weigh scales 81a, 82a and 83a at the discharge end of each hopper. When the last material has been weighed to the desired amounts, all the weighed materials are fed by conveyor 84 simultaneously onto conveyor 85 which discharges into a shredder mixer 86. The shredder 86 reduces the material to minus 1 inch and discharges it onto conveyor 87. Conveyor 87 operates at two different speeds, a slow speed to allow loading of all of the material from the feeders bins 81-83 before it is required in the plant, and a fast speed to deliver the material quickly to the plant on demand after the conveyor 87 is fully loaded. Thus there is no delay in the batch plant operation although different mixes may be put in each batch. The conveyor 87 discharges into the pugmill 91 by means of the aggregate hopper 90, or directly through a chute 88. If the sequence of the batch plant is delayed then the plant computerized controls will stop the conveyor 87 and hold the material until it is required to complete the batch cycle.

In other words, the process of reducing shingle waste may be continued from the manufacture of modified shingle waste and shingle/asphalt/sand mix to make a variety of paving compositions in a custom blend plant by the additional process steps of :

a) transferring quantities of modified shingle waste 15 to one or more first storage bins 81 and quantities of shingle/asphalt/sand mix 32 to one or more second storage bins 82;

b) discharging, from said one or more first storage bins 81, a predetermined amount of modified shingle waste 15 and discharging, from said one or more second storage bins 82, a predetermined amount of shingle/asphalt/sand mix 32 onto a first conveyor belt 84;

c) transferring, with the conveyor belt 84, predetermined amounts of modified shingle waste 15 and shingle/asphalt/sand mix 32 to a shredder mixer 86;

d) reducing said predetermined amounts of modified shingle waste 15 and shingle/asphalt/sand mix 32 to form a shredded recycle mixture 89 of approximately minus 1 inch;

e) discharging the shredded recycle mixture 89 onto a second conveyor 87 operating at a sufficiently slow speed to allow loading of all of the recycle mixture 89;

f) after discharging all of the recycle mixture 89 onto the second conveyor 87, increasing the speed of the second conveyor 87 to deliver the recycle mixture 89 to an aggregate hopper 90 of a batch plant;

g) mixing the recycle mixture 89 with predetermined quantities of heated virgin aggregate 92 to form a feed mixture;

h) introducing a controlled amount of liquid asphalt 94 into the feed mixture to complement the asphalt in the recycle mixture 89 such that the total asphalt in the feed mixture constitutes a predetermined proportion of the feed mixture;

i) mixing the heated virgin aggregate 92, the recycle mix 89, and the liquid asphalt 94 to form an asphalt hot mix paving composition; and

j) repeating the process with other predetermined quantities of modified shingle waste and shingle/asphalt; heated virgin aggregate and liquid asphalt.

The description of the preferred embodiments is intended to be illustrative and explanatory of the features of this invention. The full scope of the invention may be understood by reading the whole of the specification, both disclosure and claims, which follow hereafter.

IN THE CLAIMS:

1. A process for reducing shingle waste to modified shingle waste comprising:

a) shredding masses of shingle waste into large chunks of approximately minus 4 inches,

b) mixing the large chunks with small chunks of approximately minus 1 inch and with dust aggregate of approximately minus ¼ inches;

c) screening the large chunks, small chunks and dust aggregate on one or more screens to separate particles that are approximately minus ¼ inch in dimension from over-screen material of larger dimension;

d) mixing the over-screen material with a sufficient quantity dust aggregate of minus ¼ inches to impede agglomeration;

e) passing the mixture of over-screen material and dust aggregate past a magnet to remove metal;

f) passing the over-screen material and the dust aggregate through a hammer mill to smash the large chunks to small chunks of minus 1 inch;

g) recycling the small chunks and dust aggregate to step 2 to be mixed with the large chunks; and

h) continuing the above process steps to produce, in step c), a desired quantity of screened minus ¼ inch particles, hereafter referred to as "modified shingle waste".

2. The process of Claim 1 having an additional process step comprising:

a) mixing a predetermined quantity of modified shingle waste with a predetermined amount of pulverized recycled asphalt to make a shingle/asphalt/sand mix.

3. The process of Claim 1 having the additional process steps of:

a) mixing a predetermined quantity of modified shingle waste with a predetermined amount of pulverized recycled asphalt to make a shingle/asphalt/sand mix;

b) combining at ambient temperature a predetermined amount of modified shingle waste and a predetermined amount of shingle/asphalt/sand mix to form a recycle mixture;

c) shredding the recycle mixture to minus 1 inch;

d) combining the recycle mixture with predetermined quantities of heated virgin aggregate to form a feed mixture;

e) introducing a controlled amount of liquid asphalt into the feed mixture to complement the asphalt in the recycle mixture such that the total asphalt in the feed mixture constitutes predetermined proportion of the feed mixture; and

f) mixing the heated virgin aggregate, the recycle mix, and the liquid asphalt to form an asphalt hot mix paving composition.

4. The process of Claim 1 having the additional process steps of :

a) mixing a predetermined quantity of modified shingle waste with a predetermined amount of pulverized recycled asphalt to make a shingle/asphalt/sand mix;

b) combining at ambient temperature a predetermined amount of modified shingle waste and a predetermined amount of shingle/asphalt/sand mix to form a recycle mixture;

c) shredding the recycle mixture to minus 1 inch;

d) feeding the shredded recycle material onto a bucket elevator onto virgin aggregate being discharged from a dryer;

e) mixing the recycle mixture with predetermined quantities of heated virgin aggregate to form a feed mixture;

f) introducing a controlled amount of liquid asphalt into the feed mixture to complement the asphalt in the recycle mixture such that the total asphalt in the feed mixture constitutes predetermined proportion of the feed mixture; and

g) mixing the heated virgin aggregate, the recycle mix, and the liquid asphalt to form an asphalt hot mix paving composition.

5. The process of Claim 1 in which:

a) mixing a predetermined quantity of modified shingle waste with a predetermined amount of pulverized recycled asphalt to make a shingle/asphalt/sand mix;

b) a predetermined amount of virgin aggregate is supplied to a drum mixer;

c) a predetermined quantity of shingle/asphalt/sand mix is shredded to minus 1 inch and supplied to said drum mixer;

d) a predetermined quantity of asphalt is supplied to said drum mixer; and

e) the virgin aggregate, shingle/asphalt/sand mix and asphalt are mixed at a predetermined temperature to make a hot mix paving composition.

6. The process of Claim 1 having the additional process steps comprising:

a) mixing a predetermined quantity of modified shingle waste with a predetermined amount of pulverized recycled asphalt to make a shingle/asphalt/sand mix;

b) transferring quantities of modified shingle waste to one or more first storage bins and quantities of shingle/asphalt/sand mix to one or more second storage bins;

c) discharging, from said one or more first storage bins, a predetermined amount of modified shingle waste and a predetermined amount of shingle/asphalt/sand mix onto a first conveyor belt;

d) transferring, with said first conveyor belt, said predetermined amounts of modified shingle waste and shingle/asphalt/sand mix to a shredder mixer;

e) reducing said predetermined amounts of modified shingle waste and shingle/asphalt/sand mix to form a shredded recycle mixture of approximately minus 1 inch;

f) discharging the shredded recycle mixture onto a second conveyor operating at a sufficiently slow speed to allow loading of all of the recycle mixture;

g) after discharging all of the feed material onto the second conveyor, increasing the speed of the second conveyor to deliver the recycle mixture to an aggregate hopper of a batch plant.;

h) mixing the recycle mixture with predetermined quantities of heated virgin aggregate to form a feed mixture;

i) introducing a controlled amount of liquid asphalt into the feed mixture to complement the asphalt in the recycle mixture such that the total asphalt in the feed mixture constitutes predetermined proportion of the feed mixture;

j) mixing the heated virgin aggregate, the recycle mix, and the liquid asphalt to form an asphalt hot mix paving composition; and

k) repeating the process with other predetermined quantities of modified shingle waste and shingle/asphalt/sand mix; heated virgin aggregate and liquid asphalt.

7. A modified hammer mill comprising:

a) a container having a cylindrical wall to hold material to be reduced, said cylindrical wall having first cutting tools spaced apart at intervals projecting into the container;

b) on or more flywheels mounted on a first axle to rotate within the container;

c) a plurality of hammers, each said hammer being mounted on a flywheel, to rotate on an axis parallel to said first axis, and having a second tool mounted on said hammer to extend outwardly therefrom to swing in close proximity to said first cutting tools.

8. A modified hammer mill comprising of Claim 8 having water jets positioned to spray the cutting tools during processing to cool them and reduce erosion of the tool surfaces.

9. A shingle/asphalt/sand mix comprising a percentage amount by weight in the range of 50-85% of modified shingle waste mixed with 0-50% of sand and 0-50% of minus 1 inch particles of recycled asphalt pavement.

10. A shingle/asphalt/sand mix of Claim 9 comprising a percentage amount by weight in the range of 70-85% of modified shingle waste of minus ¼ inch particle size mixed with 0-30% of washed and classified sand and 0-30% of minus 1 inch particles of recycled asphalt pavement.

11. A shingle/asphalt/sand mix comprising a percentage amount by weight in the range of 70-80% of modified shingle waste of minus ¼ inch particle size mixed with 20-30% of sand and 0% of recycled asphalt pavement.

12. A shingle/asphalt/sand mix comprising a percentage amount by weight in the range of 70-80% of modified shingle waste of minus ¼ inch particle size mixed with at least 15% of washed classified sand and the remainder comprising minus 1 inch particles of recycled asphalt pavement.

13. A batch plant for manufacturing custom hot mix asphalt compositions comprising:

a) a plurality of material hoppers having weigh scales to store and to discharge materials for use in a hot mix paving composition, said hoppers having controllable discharge means;

b) scales associated with said material hoppers to weigh the materials discharged from each said hopper;

c) control means to store predetermined weights of materials in memory, to compare the predetermined amounts to the weights of such materials being discharged from said

hoppers and to open or close the discharge means to control the amount of materials discharged from each hopper to the predetermined weights;

d) one or more first conveyor means to receive the discharged materials and to transfer them to a shredder mixer;

e) a second conveyor means having at least two operating speeds including a slow speed to receive the predetermined weights of materials from the shredder mixer and a fast speed to deliver the materials;

f) a batch plant to receive the materials from the second conveyor means and to mix said materials with predetermined quantities of heated virgin aggregate and liquid asphalt to form an asphalt hot mix paving composition.

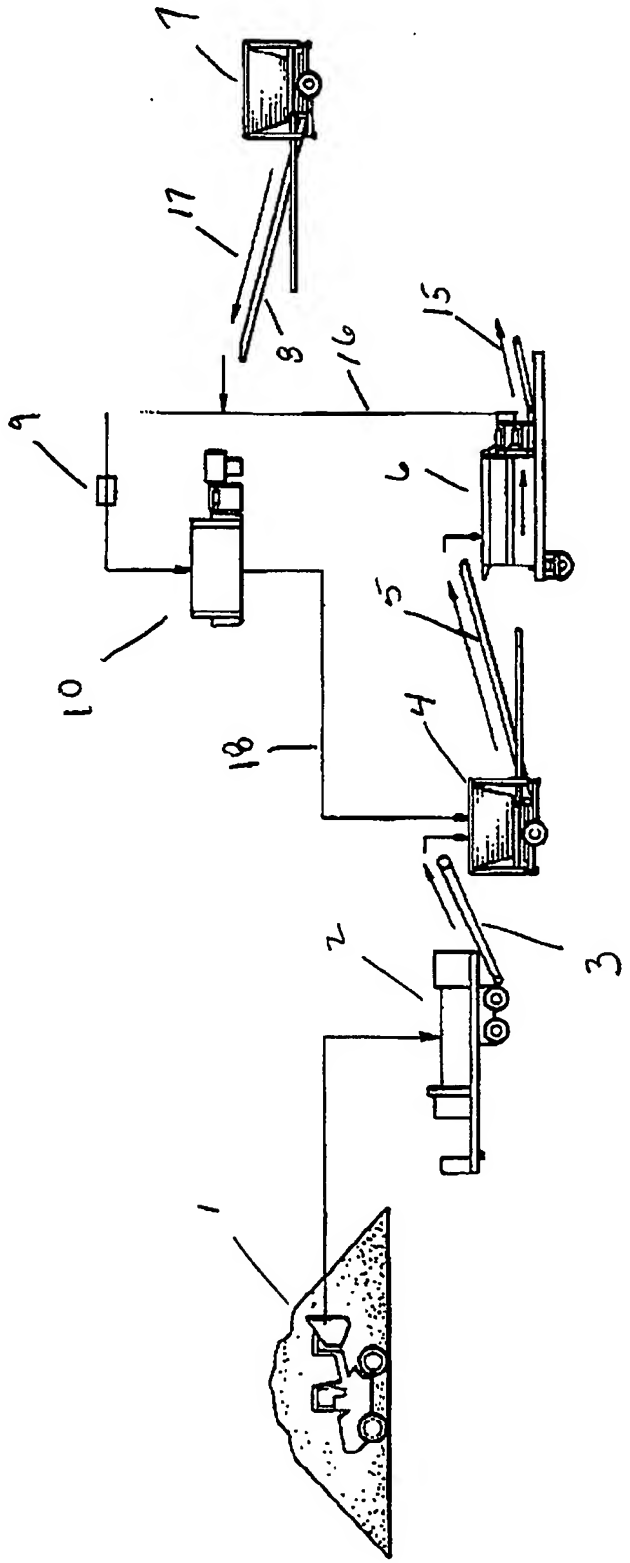

FIG. 1

(PRIOR ART)

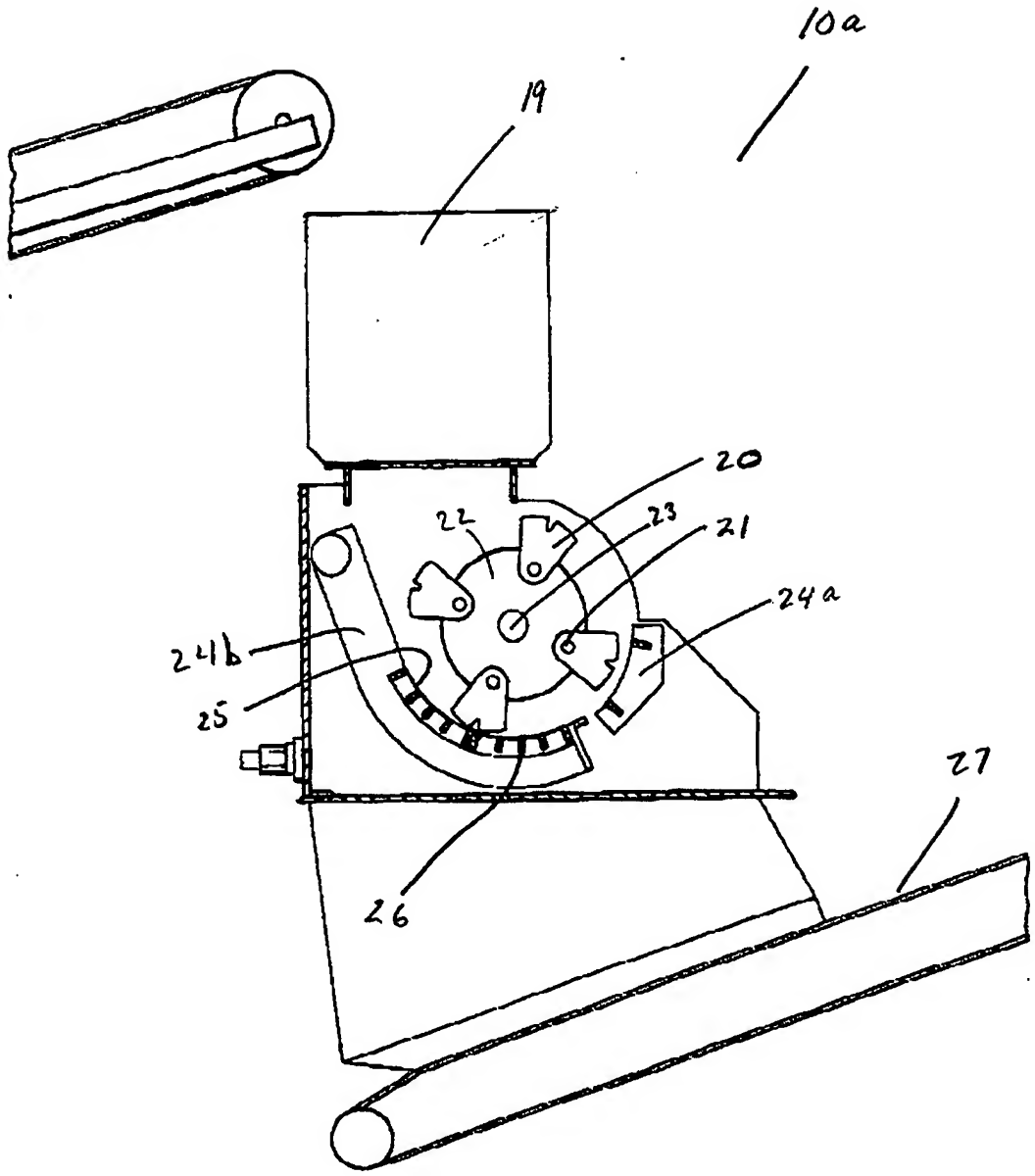

FIG. 2a

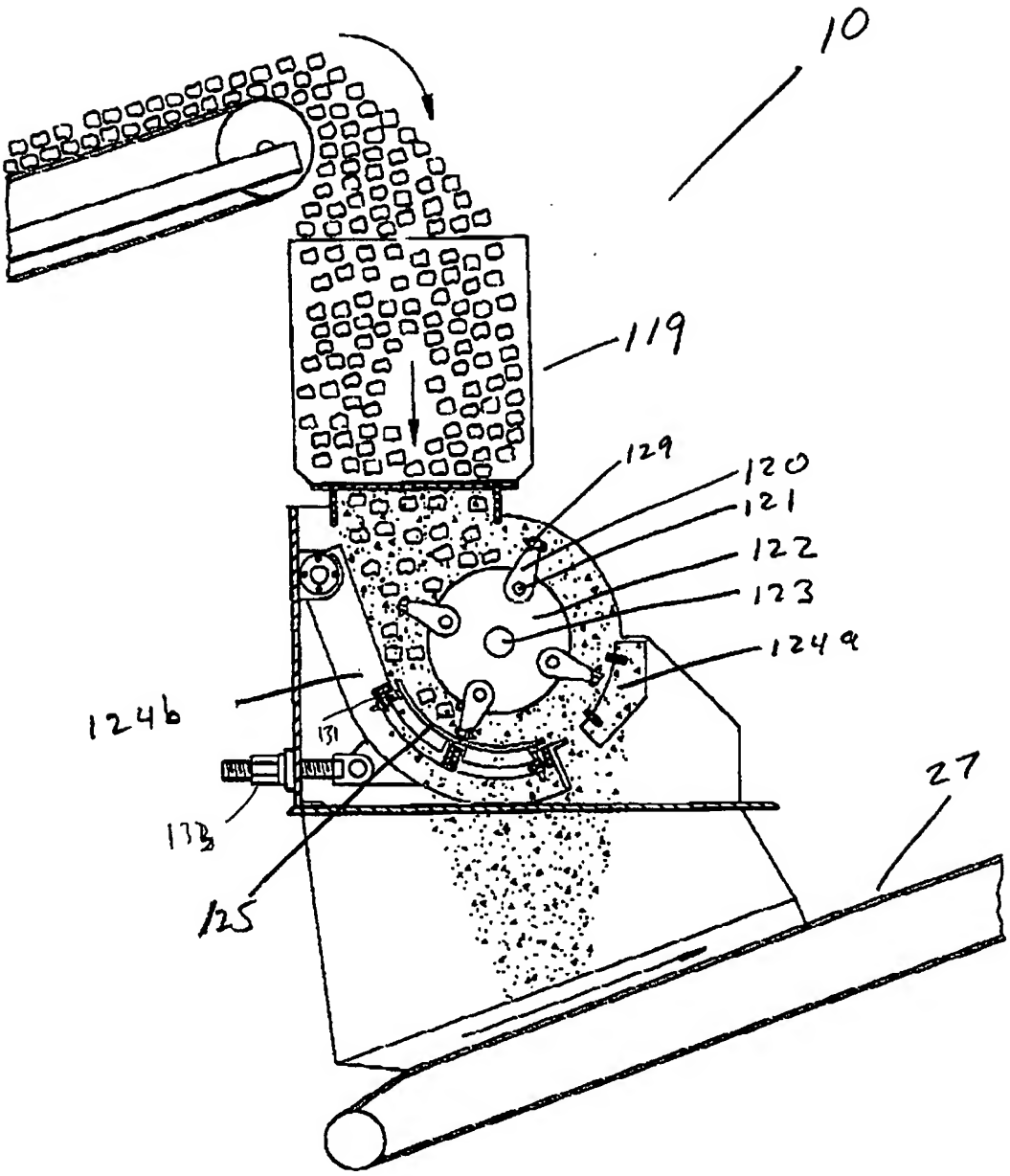

FIG. 2b

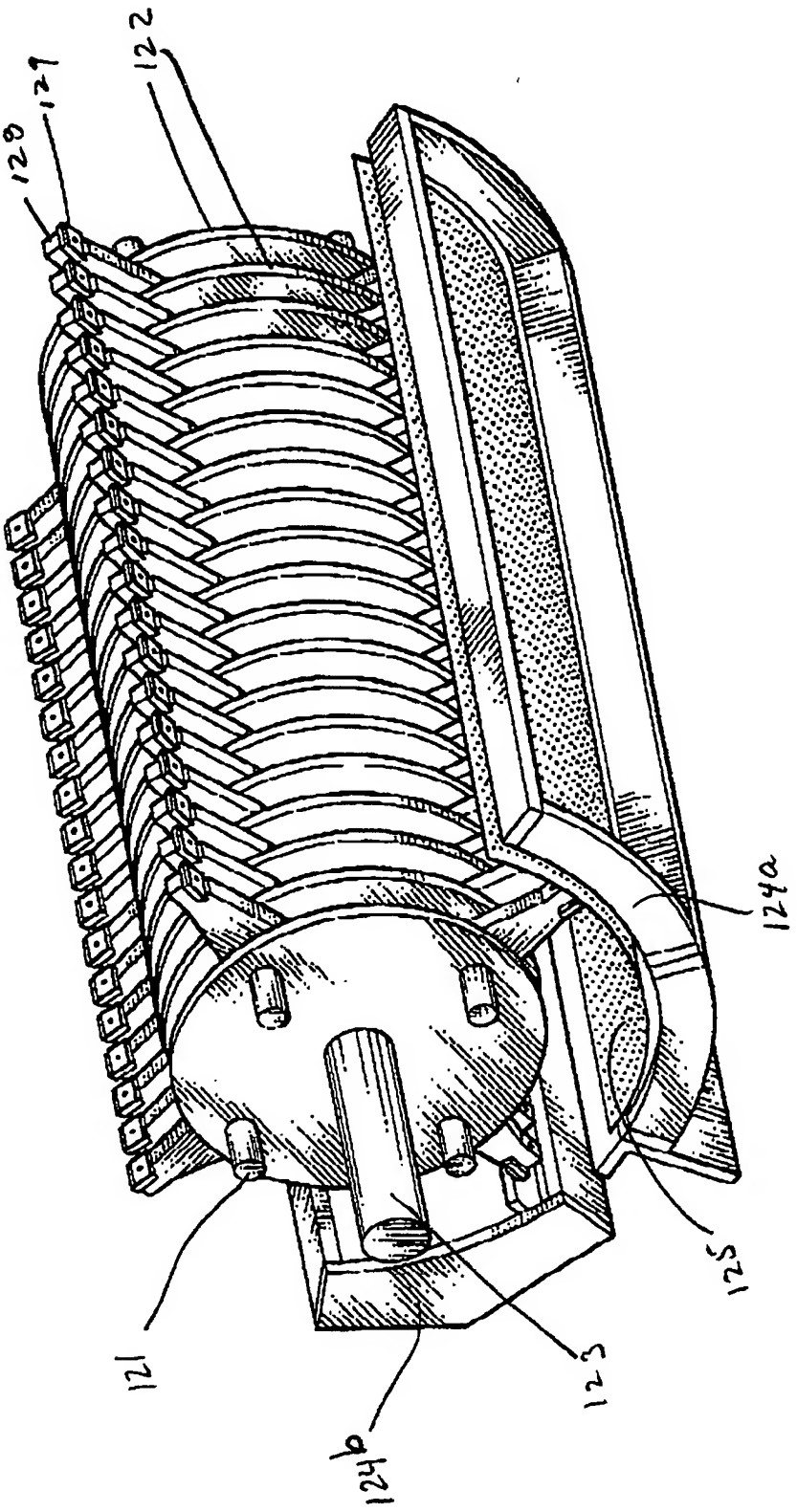

Fig 2C

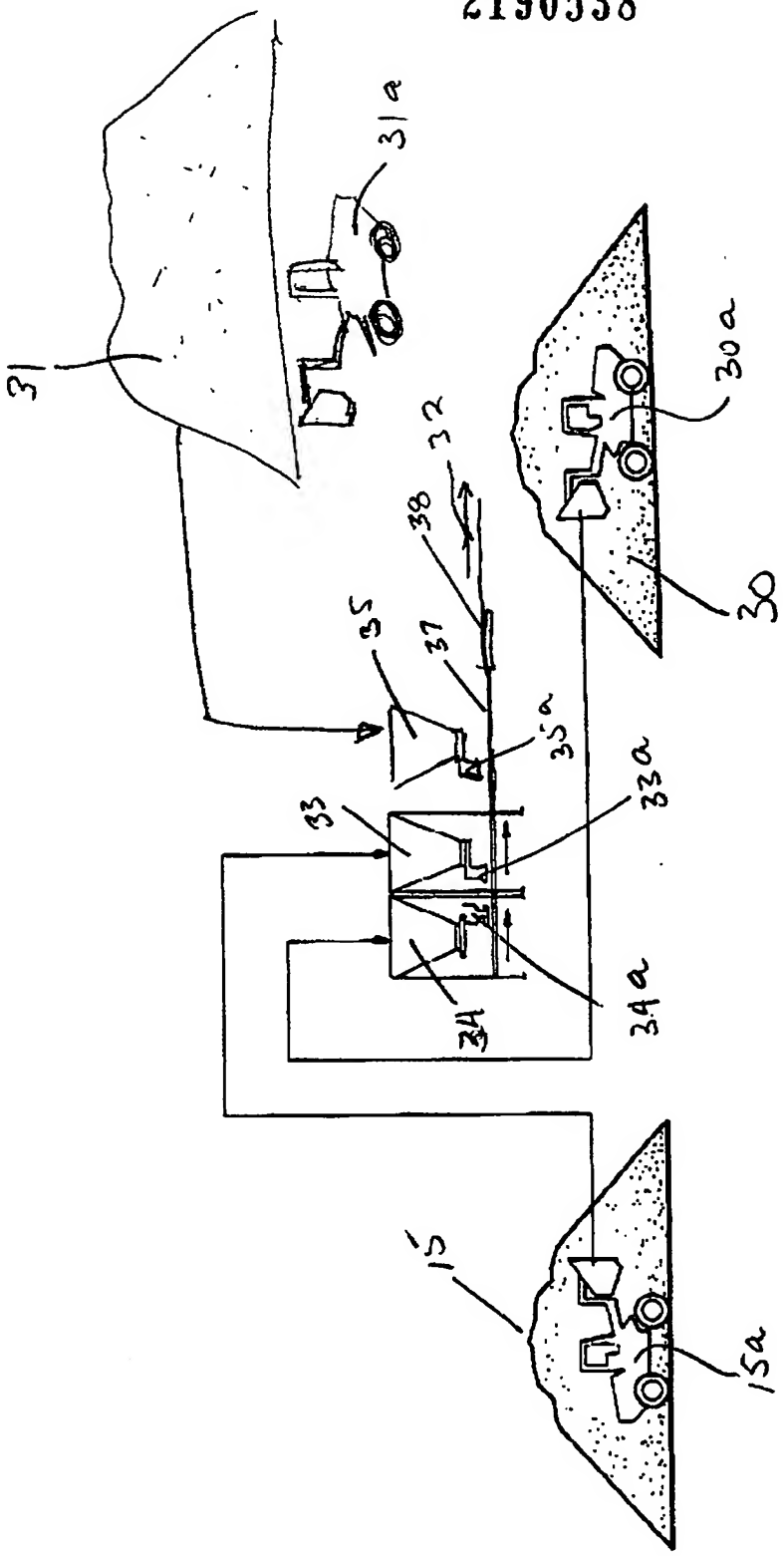

FIG. 3

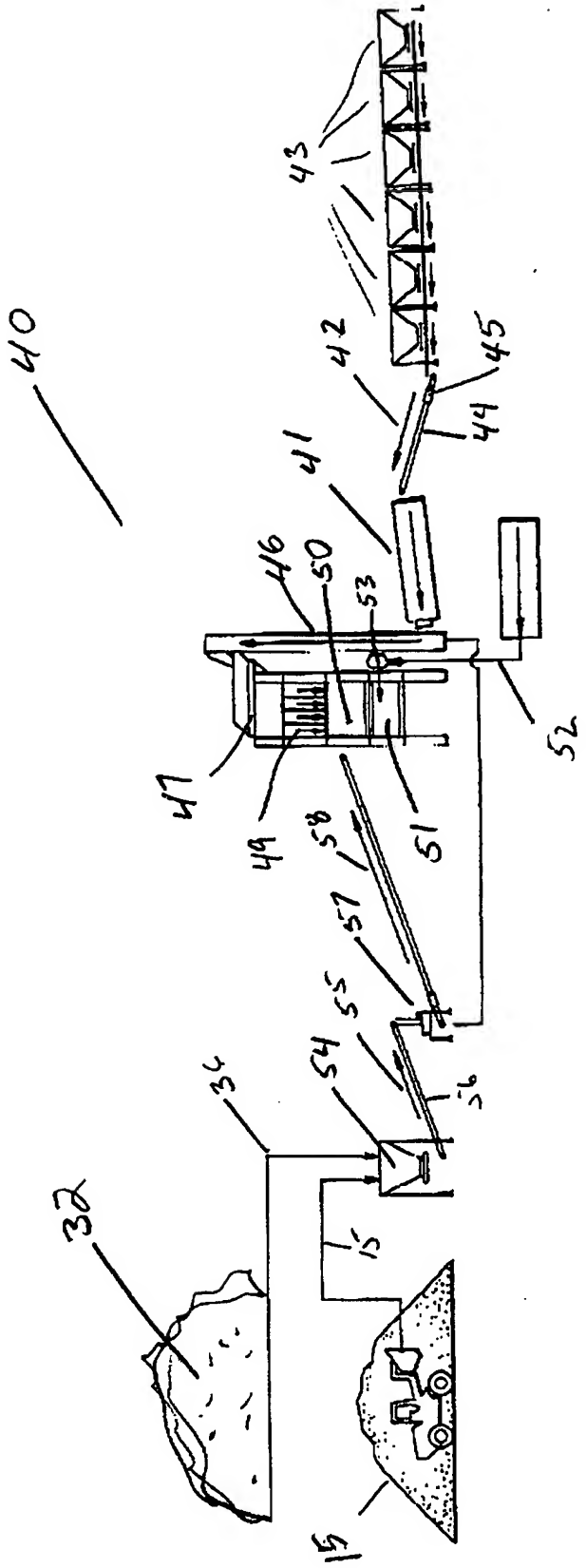

FIG. 4

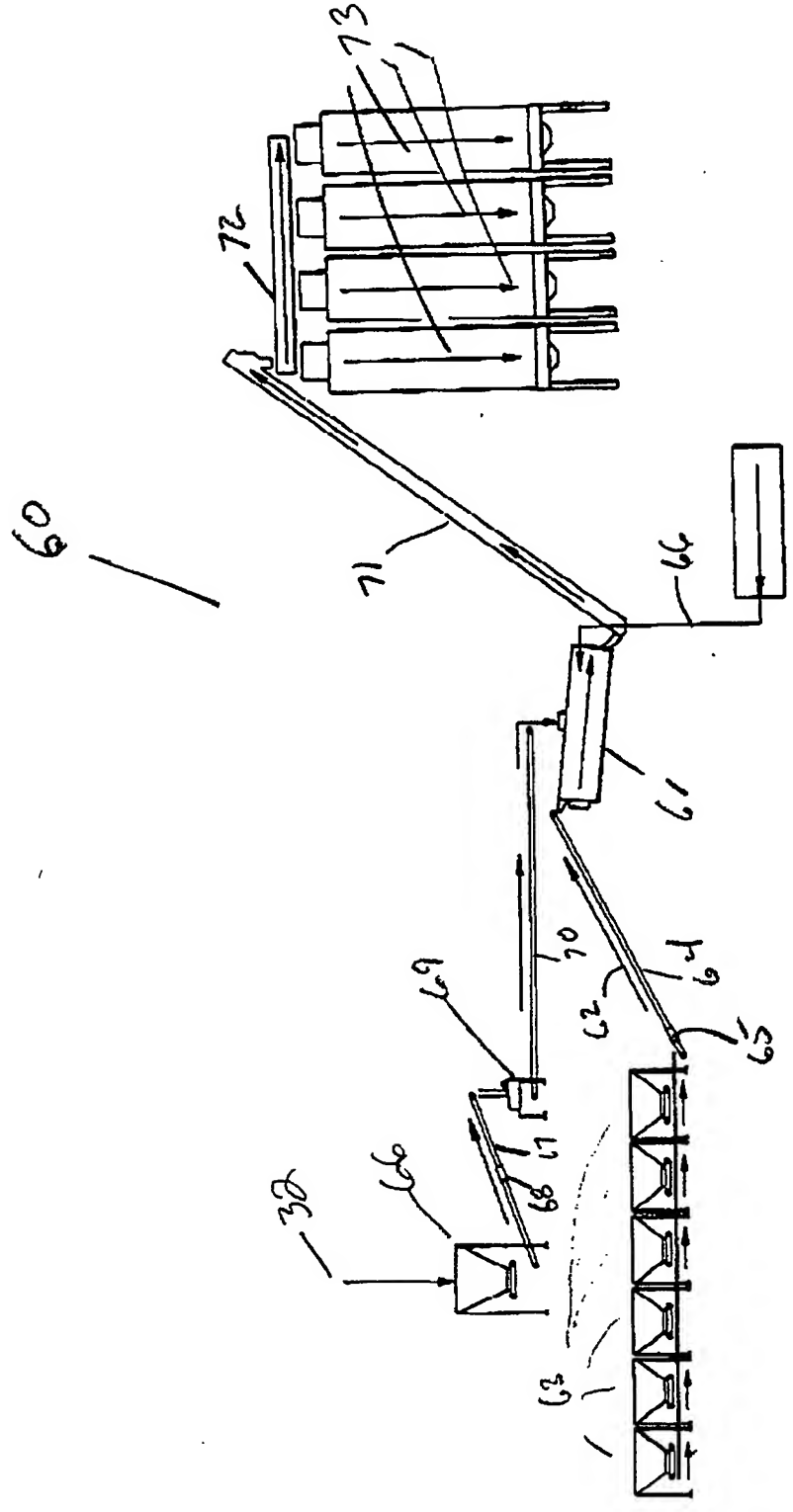

FIG. 5

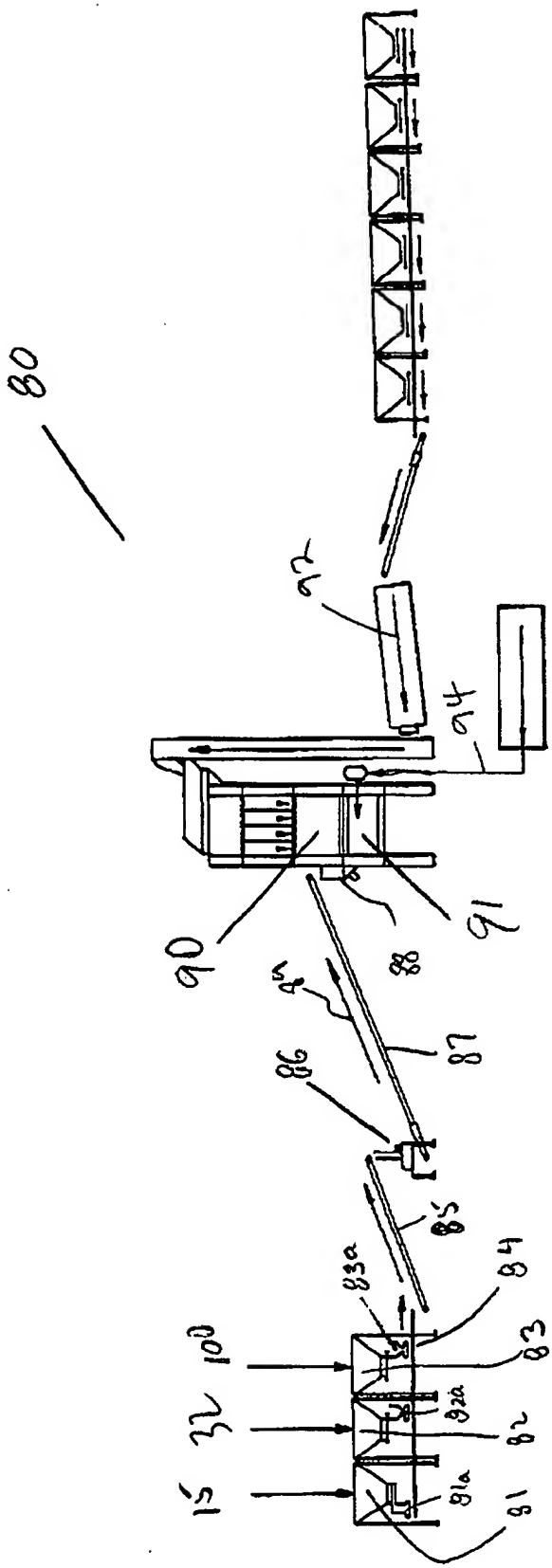

FIG. 6